MATERIALS BUREAU

TECHNICAL REPORT 95-1

EVALUATION OF HEAVY-DUTY PAVEMENT PERFORMANCE

JUNE 1995

M.A.P. CODE 7.42-6-95-1

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Technical Report 95-1
June 1995

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ABSTRACT

This report presents results of a performance evaluation of selected Heavy-Duty (HD) pavements, conducted by the Materials Bureau due to concerns expressed by some Regional Directors regarding the appearance of early distress that has developed on some HD pavements. The Materials Bureau evaluated representative HD pavements for early distress, analyzed comparison data from prior HD projects, researched available literature on fine-mix asphalt composition to help determine if the present [illegible]-percent [illegible] limit is acceptable, and sent surveys to all Engineers-In-Charge of projects constructed during the [illegible] and 1998 paving seasons for their evaluation of the HD specification. This analysis provided sufficient data to confirm modifications are needed to the current HD specification.

ABSTRACT

This report presents results of a performance evaluation of selected Heavy-Duty (HD) pavements, conducted by the Materials Bureau due to concerns expressed by some Regional Directors regarding the appearance of early distress that has developed on some HD pavements. The Materials Bureau: evaluated representative HD pavements for early distress, analyzed compaction data from prior HD projects, researched available literature on hot-mix asphalt compaction to help determine if the present 91-percent lower limit is acceptable, and sent surveys to all Engineers-In-Charge of projects constructed during the 1992 and 1994 paving seasons for their evaluation of the HD specification. This analysis provided sufficient data to confirm modifications are needed to the current HD specification.

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I. INTRODUCTION

A. Purpose

Due to concerns expressed by some Regional Directors regarding the presence of early distress on Heavy-Duty (HD) pavements the Materials Bureau began an investigation to:

1) Evaluate representative HD projects to determine the in-place performance of HD mixes, with emphasis given to early distress and rutting.

2) Review current in-place density limits contained in the HD specification to determine if the limits are consistent with available research, and appropriate to insure an impermeable pavement. Also, review the effect of any proposed change to the specification by evaluating historical HD data.

3) Review and respond to surveys received in 1992 and 1994 from Engineers-In-Charge of HD projects.

This report will summarize the findings of this investigation and provide recommendations for improvement to the current HD specification.

B. Background

Prior to 1988, the prevalent belief in the New York State Department of Transportation was that rutting in asphalt concrete pavements was not a problem. However, with increasing truck volumes, axle loads, and tire pressures--in combination with sustained high ambient temperatures--rutting became a significant problem. Over the past 6 years the Materials Bureau has put considerable effort into development of hot-mix asphalt (HMA) mix designs that are rut-resistant. Through an evolutionary process the current Heavy-Duty (HD) and Rut-Avoidance (RA) mix designs were developed.

The Department's initial experience with rutting occurred during the summer of 1988 on the Cross-Bronx Expressway, which was paved in 1987 with 1½ in. of a specially designed, high-stability surface-course mixture. This mix failed in 1988, when severe ruts developed in the wheelpaths from a combination of sustained high temperatures and a large volume of truck traffic. This experience led to development of the High-Volume (6F HV and 3 HV) bituminous concrete specifications issued in February 1989. This required that target mix gradation in the sand sizes fall below the maximum density line, that the design air-void range be increased to 3- to 5-percent, that the VMA limit be met at all design points, and that the compactive effort be increased to 75 blows per side. These changes resulted in mixes with substantially reduced asphalt contents, which were used on only a limited basis.

During 1989, the Bureau determined that the HV specification did not fully address all the factors influencing a mix's resistance to rutting. Thus, Heavy-Duty (6F HD, 7F HD, and 3 HD) specifications were developed. Similar to the HV mixes in design procedure, these mixes are characterized by the entire mix gradation falling below the maximum density line. Further, because of the HD mix's coarse gradation, the Bureau believed that the HD specification must also include a field-compaction requirement to assure achievement of acceptable in-place density. The field compaction portion of the specification requires daily monitoring of pavement density, by coring, to determine average density and uniformity of density. Using a statistical analysis procedure, the percent of the lot within limits is determined, and a Quantity Adjustment Factor (QAF) calculated and applied to determine payment.

Subsequent to development of the HD mixes, it was realized that using the HD specification in locations where it would be difficult to obtain a uniform density was not practical, specifically for urban arterial pavements. Thus, Rut-Avoidance (6F RA, 7F RA, and 3 RA) specifications were developed for use on non-access controlled pavements where a rut-resistant mix was essential. No difference exists between a mix design developed for the current RA specification and the HD specification, but RA mixes do not use a QAF to determine payment. Future performance of RA pavements should, thus be very similar to the HD pavements, as detailed in this report.

II. PAVEMENT EVALUATION

Since 1990, New York State has built 51 HD pavements, the complete list is given in Appendix A. The procedures described in Volume I of the NYSDOT Pavement Rehabilitation Manual were used to evaluate the pavements. Typically pavement data are collected on the driving lane and right shoulder in one direction of travel at a rate of one-tenth mile section per one-half mile interval. For this analysis distress data were collected on the entire pavement length. Ten projects were evaluated and the results for these projects are given in Appendix B. The selection of these projects was based on contractor and/or producer experience with HD mixtures, Region, Route, and year constructed.

A. Specific Project Review

1. I-787 in Region 1, Albany County, from the South Menands Exit to Rte 378. This 6.2-mile project built in 1992 consists of an overlay constructed with a nominal 1-in. truing-and-leveling course, 1½ in. of Type 3 HD binder, and 1½ in. of 6F HD top with a saw-and-seal treatment over the transverse joints. The major form of distress is longitudinal cracking along 43-percent of the centerline construction joint, and 60-percent of the pavement shoulder joint. Minor distresses include areas of raveling about 6 in. wide by 4 in. deep by 10 ft. long at six centerline joints on the south end of the project, and a few settled core locations with minor raveling and cracked transverse construction joints. The saw-and-seal treatment appeared to be performing well.

2. I-81 in Region 3, Oswego County, from Parish to Tinker Tavern Rd. This 17.6-mile project built in 1991 consists of a crack-and-seat treatment and an overlay constructed with a nominal 2-in. truing-and-leveling course, 2 in. of Type 3 HD binder, and 1 in. of 7F HD top. The major form of distress is longitudinal cracking along 100-percent of the centerline construction joint, and 92-percent of the pavement shoulder joint. Shoulder cracking appears to be more severe due to reflection of the underlying concrete. Minor distresses include a few pot holes, settled core locations with minor ravelling, cracked transverse construction joints and three heaves.

3. I-81 in Region 3, Oswego County, from Central Square to Parish abutting the 1991 project. This 17.8-mile project built in 1992 consists of a crack-and-seat treatment and an overlay constructed with a nominal 2-in. truing-and-leveling course, 1½ in. of Type 3 HD binder, and 1½ in. of 6F HD top. The major form of distress is longitudinal cracking along 86-percent of the centerline construction joint, and 82-percent of the pavement shoulder joint. Shoulder cracking appears to be more severe due to reflection of the underlying concrete. Minor distresses include a few cracked transverse construction joints and three heaves.

4. I-490 in Region 4, Monroe County, from Buffalo Rd. to Howard Rd. This 4.0-mile project built in 1990 consists of a crack-and-seat treatment and an overlay constructed with a variable-thickness truing-and-leveling course, 2½ in. of Type 3 HD binder, and 1½ in. of 7F HD top. The major form of distress is longitudinal cracking along 100-percent of the centerline construction joint, and 81-percent of the pavement shoulder joint. Minor distresses include 10 full-width and 20 partial-width transverse cracks, three settled core locations with minor ravelling, four cracked night joints, and 11 heaves. Cracks on this pavement were filled in 1994, but this treatment does not appear to be effective in preventing further deterioration of the pavement.

5. I-490 in Region 4, Monroe County, from Howard Rd. to the Erie Canal abutting the 1990 project. This 1.5-mile project built in 1991 consists of a crack-and-seat treatment and an overlay constructed with a variable-thickness truing-and-leveling course, 2½ in. of Type 3 HD binder, and 1½ in. of 7F HD top. The major form of distress is longitudinal cracking along 71-percent of the centerline construction joint, and 38-percent of the pavement shoulder joint. Minor distresses include 16 full-width transverse cracks, three potholes (two patched) and a few cracked transverse construction joints. Cracks on this pavement were filled in 1994, but this treatment does not appear to be effective in preventing further deterioration of the pavement.

6. I-81 in Region 7, Jefferson County, from Watertown to the Thousand Island Bridge. This 30-mile project built in 1992 consists of milling 1 in. and replacing with 1½ in. of 6F HD top. This pavement is full-depth asphalt with thermal cracks spaced at about 20- to 60-ft. intervals. All cracks were routed 3/4 in. by 3/4 in. and sealed with ASTM D3405 sealant in the fall of 1994. The major forms of distress are longitudinal cracking along 13-percent of the centerline construction joint, and 240± transverse cracks (within evaluated sections). Routing and sealing of the cracks appears effective in reducing deterioration of the pavement.

7. I-84 in Region 8, Orange County, from the Pennsylvania State Line north. This 11.0-mile project built in 1992 consists of a crack-and-seat treatment with an overlay constructed with a nominal 2-in. truing-and-leveling course, 1½ in. of Type 3 HD binder, and 1½ in. of 6F HD top. The major form of distress is longitudinal cracking along 94-percent of the centerline construction joint, and 69-percent of the pavement shoulder joint. Minor distresses include 36 transverse cracks (within evaluated sections), one pothole, one settled core patch with minor raveling and three cracked transverse construction joints. Cracks on this pavement were filled in 1994, but this treatment does not appear to be effective in preventing further deterioration of the pavement.

8. I-84 in Region 8, Orange County, from Rte 35 to Rte 17M abutting the 1992 project. This 18.5-mile project constructed in 1993 consists of a crack-and-seat treatment with an overlay constructed with a nominal 2-in. truing-and-leveling course, 1½ in. of Type 3 HD binder, and 1½ in. of 6F HD top. The major form of distress is longitudinal cracking along 97-percent of the centerline construction joint, and 66-percent of the pavement shoulder joint. Other distresses include severe raveling at various longitudinal construction joints and sections of lane-width raveling, several potholes, six asphalt patches, eight settled core locations with minor raveling, eight transverse cracks, nine cracked transverse construction joints, and one area of pumping along the edge of the driving lane and shoulder. This pavement was the subject of investigation by FHWA, Region 8, and the Main Office Materials Bureau in the spring of 1994 due to reports that the pavement was raveling and experiencing longitudinal cracking at construction joints. It was concluded that the pavement met specification requirements at the time of construction, but it was recommended that the longitudinal cracks be sealed to prevent water infiltration and the pavement be monitored frequently to identify any further signs of distress. The cracks have been filled, but some edge cracks are open more than 1 in. and the bituminous crack sealer is not performing well in these areas.

9. Rte 17 in Region 9, Delaware County, from the Broome County Line to Deposit. This 3.6-mile project built in 1992 consists of a crack-and-seat treatment with an overlay constructed of a nominal 2-in. truing-and-leveling course, 1½ in. of Type 3 HD binder, and 1½ in. of 6F HD top. The major form of distress is longitudinal cracking along 100-percent of the centerline construction joint, and 53-percent of the pavement shoulder joint. Minor distresses include 40 transverse cracks (within evaluated sections), two asphalt patches, and two heaves.

10. Rte 17 in Region 9, Delaware County, from Deposit to Hancock abutting the 1992 project. This 10 mile project built in 1993 consists of a crack-and-seat treatment with an overlay constructed of a nominal 2-in. truing-and-leveling course, 1½ in. of Type 3 HD binder, and 1½ in. of 6F HD top. The major form of distress is longitudinal cracking along 35-percent of the centerline construction joint, and 70-percent of the pavement shoulder joint. Due to segregation of the asphalt mix during production, eight sections of pavement were milled and patched with HD material in the spring of 1994. Minor distresses include four cracked transverse construction joints. Some cracks have been filled, but this treatment does not appear to be effective in preventing further deterioration of the pavement.

B. Project Summary

No rutting was observed on any of the evaluated HD pavements, but some showed signs of distress resulting from reduced durability. The major form of distress generally is longitudinal cracking along construction joints in the form of centerline and edge cracking. Other distresses include transverse cracking at construction joints, settlements and heaves, raveling, core-hole distress, potholes, and pumping. Due to their design, HD pavements may be more susceptible to durability distress than regular 6F and 7F mixes, because they have coarser aggregate gradations and a reduced asphalt content.

III. REVIEW OF IN-PLACE DENSITY LIMIT

None of the pavement distress noted during the evaluations of the selected projects can be directly attributed to premature aging (raveling and fatigue cracking), but the Materials Bureau is very concerned regarding the susceptibility of HD mixes to this type of distress because of their coarser gradations and low asphalt content. Thus, it is essential that the specified in-place density result in an impermeable pavement, thereby maximizing the performance of the pavement.

The current HD specification requires in-place compaction in the range of 91- to 97-percent of the mixture's average daily maximum theoretical density (MADMTD). The compacted pavement thus contains 3- to 9-percent air-voids. Current available research suggests that pavements with air-void levels of approximately 7-percent or less have void structures that are not interconnected and, thus essentially impermeable. Pavements with air-void levels greater than about 15-percent have an interconnected void structure and, thus permeable or free-draining. Pavements compacted with an air-void range between 7- and 15-percent may become saturated with water and not allow free-draining of the pavement. The term "pessimum voids" may be used to describe this type of void structure. The HD specification presently allows compaction in the 7- to 9-percent air-void (pessimum) range. The pessimum voids concept represents both quantity (amount of voids in the mixture) and quality (size, distribution, and interconnection) as they affect the performance of pavements. An important factor affecting pavement performance is the rate of permeability, which involves both size of the voids and their degree of interconnection (Terrel et al. 1993).

Researchers have concluded that a 1-percent increase in air-voids, over the base air-void level of 7 percent, will result in about a 10-percent (or about 1 year) loss in pavement life or performance (Linden et al. 1989). Fatigue life, (the time from construction to significant fatigue cracking), of asphalt pavement is reduced from 10- to 30-percent for each 1-percent increase in air-voids over 7-percent (Linden et al. 1989). It has been shown that the effective thickness (strength) of the asphalt pavement layers will decrease as the air-voids increase over 7 percent (Linden et al. 1989). Higher air-void levels can also be expected to increase aging and oxidation of the asphalt cement, which results in stripping and raveling of the pavement.

The National Asphalt Paving Association's Hot Mix Asphalt Materials, Mixture Design and Construction manual contains information on water-infiltration susceptibility of asphalt pavements. A relationship between air-voids and permeability shows that as air-void levels exceed 7-percent, permeability increases exponentially until the pavement becomes essentially free-draining at 15-percent air-voids (Roberts et al. 1991). From studies conducted on pavements in the pessimum void range, it has been concluded that dense-graded hot-mix asphalt mixtures (such as those used in New York State) should be constructed with an initial air-void content below 8 percent and a final air-void content, after years of traffic, above 3 percent to reduce rutting (Roberts et al. 1991).

Linden et al. 1989 conducted a questionnaire survey of 48 state highway agencies on their compaction practices, resulting in a summary of compaction limits specified to optimize pavement performance. Of the 21 agencies using the same measure of compaction as New York, one bases compaction on 90-percent of the total theoretical maximum density (TMD), one uses 91-percent TMD, 12 use 92-percent TMD, two use 92.5-percent TMD, and five use 93-percent TMD. New York did not respond to this survey, but (as previously stated) uses 91-percent of the theoretical maximum density. Only two state agencies responding to this survey use a TMD less than 92 percent.

The original 91-percent lower limit used in the HD Specification was based upon a previous special specification for air-void controlled hot-mix asphalt pavement, which did not use statistical analysis. It required the pavement to be sufficiently compacted to achieve a maximum of 7-percent air-voids, based on obtaining five to ten cores per day per 1500 lane-feet paved, and averaging the air-void results. The average air-void result was compared to a table of results to obtain the Quantity Adjustment Factor (QAF). The HD specification, however, is statistically based, and requires four cores be taken and evaluated to determine the percent-within-limits (PWL), which is used to determine the QAF. This procedure uses both average density and standard deviation among the pavement cores, requiring the contractor to strive for both an acceptable density and uniform compaction.

During development of the HD specification, data from the air-void controlled specification was analyzed using the PWL concept to assist in establishing the lower air-void limit. This procedure should be considered suspect, because the data were obtained from projects where consistency was not a requirement. Also, it has been determined from reviewing history of the development of the present lower limit that a 92 percent limit appeared workable. However, due to concern over changes in mix gradation and design method, it was believed this limit would be too restrictive, and it thus was lowered to 91 percent.

To determine if a 92-percent lower limit was workable, the pavement compaction data from 51 HD pavements constructed from 1990 through 1994 was analyzed. The average compaction results, at the 91-percent lower limit, are 96.90 PWL with a QAF of 103.30 percent. When the same compaction data were analyzed for the proposed 92-percent lower limit, average results were 91.40 PWL with a QAF of 100.01 percent. Increasing the lower limit to 92-percent decreased the number of bonus days by about 19 percent, and also decreased the number of 100-percent (or greater) payment days by 19 percent, but continued to yield an average payment factor greater than 100-percent. Thus we believe the proposed increase to the lower limit will not cause undue distress to contractors.

Compaction test results for 2080 cores were analyzed for this report; of these, 112 cores (5.38 percent) showed 91- to 92-percent compaction, or 8- to 9-percent air-voids. Calculation of average percent MADMTD for the cores resulted in 520 sets of compaction results. Of the 520 QAFs calculated, 439 were equal to 105-percent with the 91-percent lower limit, and 355 were equal to 105-percent when the lower limit was increased to 92-percent. Also, 465 QAFs were greater than or equal to 100-percent at the 91-percent lower limit, and 375 were greater than or equal to 100-percent when the lower limit was increased to 92-percent. For a typical listing of the HD pavement data analyzed for this report see Appendix C.

Available literature was thoroughly researched on air-void content, as it relates to pavement performance, as well as NYSDOT's own HD compaction data from 1990 through 1994, and it is believed that an increase in lower compaction limit is warranted. A concern exists that if the lower specification limit is not increased from 91-percent to 92-percent, with a potential future limit between 92- and 93-percent, HD pavements will be potentially subject to early distress resulting from water infiltration and saturation. Thus, increasing the lower limit to 92-percent is recommended. Once sufficient data is compiled at the 92-percent limit a similar evaluation will be conducted to determine if it is feasible to raise the lower limit further to effectively eliminate the pessimum void issue on HD pavements.

IV. ENGINEERS IN-CHARGE SURVEY RESULTS

Engineers-In-Charge (EICs) of eleven projects constructed in 1994 that used Heavy Duty asphalt concrete were sent a questionnaire by the Materials Bureau requesting their assessment of the current HD specification. A similar questionnaire was sent to EICs responsible for nine projects that used the HD specification in 1992. Their suggestions and comments will be used by the Bureau in revising the HD specification. Appendices D and E summarize the 1992 and 1994 survey results. Both surveys yielded similar comments from the EICs. Their responses are summarized here:

The majority of EICs prefer using performance-type specifications such as HD, and did not encounter difficulties with contractors in enforcing the specification. For the most part, the EICs, their staffs, and contractors understood the statistical portion of the specification. The majority of EICs considered construction of a test strip to be beneficial, and were satisfied with the rolling pattern used by the contractors on their projects, but indicated that only about half of the contractors varied the rolling pattern from day to day to address changes in the mix, the weather, or the site. Every EIC indicated that the contractors used a nuclear gauge to monitor pavement density, and most believed the gauge operator was effectively controlling the rolling pattern. The majority of contractors took extra core samples to update the nuclear gauge and to verify state test results. Most core holes were backfilled by the Contractor daily, using either a vibratory roller operating in the static mode or a hand-held tamper. Only about half the EICs were satisfied with the pavement quality (i.e. texture, smoothness, rideability, etc.) constructed with the HD mixes.

EICs also responded with many pertinent comments on the current HD specification. Many pertained to better pavement quality by requiring the contractor to accept more responsibility. Many EICs indicated that there should be a ride quality test (smoothness/profilograph) with an incentive/disincentive factor incorporated into the specification. Many EICs indicated it was difficult to construct longitudinal and transverse joints due to the coarse aggregate gradation and low asphalt content typical of HD mixes. Many EICs indicated the need for a method, such as coring, to be included in the HD specification to measure quality of joint construction. Some EICs also believed it appropriate to have a guideline in the HD specification addressing the preferred method to fill core holes and to limit the number of cores taken. They did not believe it necessary for the contractor to take duplicate core samples.

Based on the EIC responses, the Bureau anticipates dealing with the issue of joint construction and testing, segregation of coarse mixes, and raveling. Rideability is a separate topic that may be addressed in a separate specification in the future. EIC responses were constructive and positive--they appear to be interested in improving the HD specification through their field experience.

V. CONCLUSION

Based on field evaluation of HD pavements and research conducted on pavement compaction it has been concluded that the current version of the HD specification issued February 18, 1993 should be revised. The concerns that will be addressed while revising the specification include the following:

1. Develop a better method to test compaction of longitudinal joints to be incorporate into the HD specification. The preferred method includes taking randomly located cores per lot per longitudinal joint to determine the quality of joint construction.

2. Develop and require use of a better method for backfilling core-holes to reduce pavement distress in those areas. The preferred method includes filling the core-holes with multiple lifts of the same HD material and compacting with a heavy hand-held tamper.

3. Apply a tack-coat between pavement lifts to reduce potholes and increase the bond between lifts, thus strengthening the entire pavement. Tack-coat is a relatively inexpensive item that Region 1 now requires on all of their RA and HD projects.

4. Load delivery trucks with multiple dumps to reduce segregation that may result in raveling when material is supplied from a storage silo. Material transfer devices (MTDs) may also help reduce segregation, operating in front of the paver and blending the asphalt mixture like a pugmill in an asphalt plant. The paver should also move continuously, creating a smoother, more uniform mat.

5. Schedule a crack sealing and/or filling treatment for every HD pavement the spring or fall following construction. This treatment should specify either Item 18403.7504 - Sealing Cracks In Asphalt Concrete Pavement, ASTM D3405, or Item 18403.7505 - Filling Cracks and/or Joints In Pavements and Shoulders Using ASTM D3405 with Recycled Tire Rubber. Item 18403.7504 consists of routing (or sawing), cleaning, and sealing the cracks with sealant material that meets

the requirements of ASTM D3405. Item 18403.7505 consists of cleaning and filling cracks with sealant material that meets the requirements of ASTM D3405 with recycled tire rubber. The Regional Materials Engineer should follow the most recent Department guidelines when selecting the treatment to be followed.

6. Increase the lower compaction limit from 91-percent to 92-percent with a future limit between 92- and 93-percent. This increase will result in a pavement void structure that is not interconnected and thus essentially impermeable. This increase will significantly reduce the potential for premature pavement failure from fatigue cracking of the asphalt pavement and excessive aging of the asphalt cement.

These modifications to the HD specification will result in improved performance from HD pavements.

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APPENDIX A

HEAVY DUTY PROJECTS

HEAVY DUTY PROJECTS
1990 - 1992 CONSTRUCTION SEASONS

RTE	LOCATION	"D" NO.	PIN NO.	CONTRACTOR	PRODUCER
		1990 - LETTINGS			
I-490	Buffalo Rd. - Howard Rd.	253260	4002.86.000	Crane-Hogan Struct. Systems, Inc.	Rochester Asphalt Matls.
I-84	Taconic State Pkwy. - Rte 311	253281	8061.81.000	Thalle Construction Co., Inc.	Peckham Materials Corp. Patterson Blacktop Corp. Thalle Construction Co. Inc.
		1991 - LETTINGS			
I-690	Van Vleck Blvd. - Hiawatha Blvd.	253751	3506.20	Santaro Industries, Inc.	General Crushed Stone Co.
I-81	Parish - Tinker Tavern Rd.	253722	3501.03	Barrett Paving Matls., Inc.	Barrett Paving Matls., Inc. General Crushed Stone Co.
I-490	Howard Rd. - Erie Canal	253556	4002.92.301	Sealand Contractors Corp.	Rochester Asphalt Matls.
I-81	Kellogg Hill Rd. - Rte 342	253729	7500.58	Green Island Construction Co.	Barrett Paving Matls., Inc. General Crushed Stone Co.
I-84	Rte 9D - Rte 9	253698	8061.93	Ritangela Construction Corp.	Maybrook Materials Inc.
I-84	Rte 311 - Ludington Rd.	253699	8061.97	Peckham Materials Corp.	Peckham Materials Corp. Patterson Blacktop Corp. Thalle Construction Co., Inc.
Expwy.	Bruckner Expwy.	253752	X803.38.000	Migoya Construction	Canal Asphalt Co.
Expwy.	Cross-Westchester Expwy.	253700	8729.36	Morano Construction	County Asphalt Co., Inc. Peckham Materials Corp.
Rte 25A	Summer Ave. - Maple Ave.	253238	0327.74	J. D. Posillico, Inc.	Posillico Bros. Asphalt Co.
		1992 - LETTINGS			
I-787	South Menands Exit - Rte 378	253896	1051.43.302	Callanan Industries, Inc.	Callanan Industries, Inc.
I-81	Central Square - Parish	254083	3501.06	Barrett Paving Matls., Inc.	Barrett Paving Matls., Inc.
Rte 33A	Rte 204 - Pixley Rd.	254453	4006.06.000	Reed Paving, Inc.	–
Rte 17	Tioga Co. Ln. - West	253913	6066.04.321	Lancaster Development, Inc.	Barrett Paving Matls., Inc.
I-81	Watertown - Thousand Island Br.	253880	7500.59	Lancaster Development, Inc.	Barrett Paving Matls., Inc.
Rte 17	Suffern	253854	8128.00	Halmar Contruction	County Asphalt Co., Inc. Plaza Materials Co.
I-84	Connecticut State Line - West	253994	8061.99.111	Thalle Construction Co., Inc.	Thalle Construction Co., Inc.
I-84	Pennsylvania State line - North	254001	8061.98.311	Ritangela Construction Corp.	Maybrook Materials, Inc.
Rte 17	Sullivan Co. Ln. - Bushville Rd.	253996	9056.30.321	Ritangela Construction Corp.	Maybrook Materials, Inc.
Rte 17	Delaware Co.	254032	9066.24	Harrison & Burrowes Br. Constructors, Inc.	Barrett Paving Matls., Inc. Broome Bit. Prods., Inc.
Rte 17	Broome Co. Ln. - Deposit	254070	9066.18.301	Fahs-Ralston Paving Corp.	Broome Bit. Prods., Inc.
Rte 17	Rte. 17 Bridges	254261	9066.27.000	Harrison & Burrowes Br. Constructors, Inc.	–
Rte 17	Broome Co. Ln. - Vestal	254099	9066.39.301	Riflemburgh Construction, Inc.	Barrett Paving Matls., Inc.
Rte 278	Bruckner Expwy.	253752	X803.38.311	Migoya Construction	Nigro Brothers
I-495	Long Island Expwy.	254225	X227.75.000	A.F.C. Enterprises, Inc.	–

HEAVY DUTY PROJECTS
1993 - 1994 CONSTRUCTION SEASONS

RTE	LOCATION	"D" NO.	PIN NO.	CONTRACTOR	PRODUCER
1993 - LETTINGS					
I-490	Brighton/Pittsford	254600	4088.04.311	Sealand Contractors Corp.	Rochester Asphalt Matls.
Rte 17	Randolph - Salamanca	254572	5006.43.321	Depew Development, Inc.	Jamestown Macedam, Inc.
Pkwy.	Cross-County Pkwy.	254388	8099.35.301	Halmar & Defoe Construction	Plaza Materials Co.
I-84	Rte 35 - Rte 17M	254428	8062.00.311	Ritangela Construction Corp.	Maybrook Materials, Inc.
Pkwy.	Sprainbrook Pkwy.	254541	8106.16.321	Halmar Construction	County Asphalt Co., Inc.
Rte 17	Monticello	254313	9066.44.321	Sullivan LaFarge	Sullivan LaFarge
I-81	Binghamton	254440	9500.55.311	Academe Paving, Inc.	Academe Paving, Inc.
Rte 17	Deposit - Hancock	254537	9066.22.321	Fahs-Ralston Paving Corp.	Broome Bit. Prods., Inc.
Expwy.	Gowanus Expwy. - 92nd St.	254574	X730.42.000	Grace Industries	–
Pkwy.	Cross-Island & Laurelton Pkwys.	254597	X026.08.000	G.A.F. Construction Corp.	–
Expwy.	Bruckner Expwy.	254615	X730.28.000	Kiska Construction Corp.	–
1994 - LETTINGS					
I-87	Saratoga Co. Ln. - Exit 20	254974	1728.28.321	Callanan Industries, Inc.	Callanan Ind., Inc.
I-87	Exit 20 to Exit 22	254975	1721.40.321	Callanan Industries, Inc.	Callanan Ind., Inc.
I-490	Penfield Rd. - Rte 35	254600	4088.04.311	Sealand Contractors, Corp.	Rochester Asphalt Matls.
I-190	Rte 31 - Military Rd.	254827	5050.77.311	Cerrone, Inc.	Niagara Stone Corp.
I-390	Wayland - Dansville	256066	6218.11	Depew Develop., Inc.	General Crushed Stone Co.
I-87	Chazy - Canadian Border	254911	7720.59.311	Kubricky Construction Corp.	Plattsburgh Quarry, Inc.
I-84	Rte 9 - Taconic Pkwy.	256029	8062.01.311	Thalle Construction Co., Inc.	Thalle Construction Co., Inc.
Rte 17	Exit 81 - Exit 82	254769	9066.38.321	Fahs-Ralston Paving Corp.	Broome Bit. Prods., Inc.
Rte 17	Old Rt. 17 to Greenflat	254992	9066.42.321	Lancaster Development, Inc.	Barrett Paving Matls., Inc.
I-81	Pennsylvania State Ln. - Exit 1	256013	9500.58.311	Academe Paving, Inc.	Academe Paving, Inc.
Rte 17	Exit 99 - Exit 100	256087	9066.45.301	Ritengela Construction Corp.	Maybrook Materials, Inc.
Rte 135	Rte 24 - Rte 25	256026	0050.23.321	Hendrickson Bros., Inc.	Rason Asphalt, Inc.
I-495	Grand Central Pkwy. - N.Y.C. Ln.	254867	X228.52.301	Grace Industries	–
I-87	Triborough Br. - Westchester Co. Ln.	256005	X720.28.301	New York Paving, Inc.	–

APPENDIX B

DISTRESS SUMMARY

Distress Summary of Heavy Duty Projects

Projects Evaluated

1. Region 1
   Route I-787
   Number: D253896
   Year Paved: 1992

2. Region 3
   Route I-81
   Number: D253722
   Year Paved: 1991

3. Region 3
   Route I-81
   Number: D254083
   Year Paved: 1992

4. Region 4
   Route I-490
   Number: D253260
   Year Paved: 1990-1991

5. Region 4
   Route I-490
   Number: D253556
   Year Paved: 1991

6. Region 7
   Route I-81
   Number: D253880
   Year Paved: 1992

7. Region 8
   Route I-84
   Number: D254001
   Year Paved: 1992

8. Region 8
   Route I-84
   Number: D254428
   Year Paved: 1993

9. Region 9
   Route 17
   Number: D254070
   Year Paved: 1992

10. Region 9
    Route 17
    Number: D254537
    Year Paved: 1993

Legend

Severity Levels:

N	=	None. No cracks present.
P	=	Present. Number identified.
L	=	Single crack. This includes cracks that are effectively sealed.
M	=	Multiple cracks. This includes cracks that have been effectively sealed.
H	=	Multiple cracks with potholes. This includes cracks that have pieces broken or missing.

Region 1
Route I-787
"D" Number: D253896
Year Paved: 1992
Sealed: Saw & Seal
Inspected: North

Full width transverse cracking:
N= 0
L= 2
M= 0
H= 0

Longitudinal cracking:
N= 57%
L= 43%
M= 0%
H= 0%

Edge cracking:
N= 40%
L= 60%
M= 0%
H= 0%

Notes:

1. Pot holes:
   - One (1) pot hole along centerline joint.

2. Core holes:
   - Two (2) settled core hole patches.

3. Night joints:
   - Two (2) cracked night joints.

4. Ravelling:
   - Ravelling at six (6) centerline joints on south end of project at bridge approach.

5. General:
   - Saw and seal treatment in fair condition.

Region 3
Route I-81
"D" Number: D253722
Year Paved: 1991
Sealed: No
Inspected: North

Heaves:
P= 3

Longitudinal cracking:
N= 0%
L= 100%;
M= 0%
H= 0%

Edge cracking:
N= 8%
L= 26%
M= 66%
H= 0%

Notes:
1. Pot holes:
   - Two (2) pot holes.

2. Core holes:
   - Two (2) settled core hole patches.

3. Night joints:
   - One (1) cracked night joint.

4. Edge cracking:
   - Edge cracking is more severe due to reflection from concrete below.

5. Heaves:
   - Five (5) full width and two (2) partial width heaves.

Region 3
Route I-81
"D" Number: D254083
Year Paved: 1992
Sealed: No
Inspected: North

Heaves:
P= 3

Full width transverse cracking:
N= 0
L= 1
M= 0
H= 0

Longitudinal cracking:
N= 13%
L= 86%
M= 1%
H= 0%

Edge cracking:
N= 18%
L= 46%
M= 36%
H= 0%

Notes:
1. Transverse joints:
   - Transverse joints sawed and sealed at 60 foot intervals between reference markers 1034 and 1052.

2. Night joints:
   - Three (3) cracked night joints.

3. Edge cracking:
   - Edge cracking is more severe due to reflection from concrete below.

4. Heaves:
   - Heaves have been ground full width and sealed.

Region 4
Route I-490
"D" Number: D253260
Year Paved: 1990 - 1991
Sealed: Yes
Inspected: West

Heaves:
P= 11

Full width transverse cracking:
N= 0
L= 10
M= 0
H= 0

Longitudinal cracking:
N= 0%
L= 95%
M= 5%
H= 0%

Edge cracking:
N= 19%
L= 63%
M= 18%
H= 0%

Notes:
1. Core holes:
   - Two (2) core holes are void of patching material and some ravelling also exists in these areas.
   - One (1) settled core hole patch.

2. Transverse joints:
   - Twenty (20) transverse cracks in various locations.

3. Night joints:
   - Four (4) cracked night joints.

4. Edge cracking:
   - Multiple edge cracking in east bound direction.

Region 4
Route I-490
"D" Number: D253556
Year Paved: 1991
Sealed: Yes
Inspected: West

Full width transverse cracking:
N= 0
L= 16
M= 1
H= 0

Longitudinal cracking:
N= 29%
L= 62%
M= 9%
H= 0%

Edge cracking:
N= 78%
L= 22%
M= 0%
H= 0%

Notes:
1. Pot holes:
   - Pot hole at intersection of centerline joint and night joint 12 inches x 6 inches (patched).
   - Pot hole at left edge joint and shoulder 5 foot long x 4 foot wide (patched).
   - Pot hole in wheel path at night joint approximately 6 inches x 6 inches.

2. Night joints:
   - Two (2) cracked night joints.

Region 7
Route I-81
"D" Number: D253880
Year Paved: 1992
Sealed: Routed and Sealed
Inspected: North/South

Full width transverse cracking:
N= 0
L= 208
M= 0
H= 0

Longitudinal cracking:
N= 87%
L= 13%
M= 0%
H= 0%

Edge cracking:
N= 99%
L= 1%
M= 0%
H= 0%

Notes:
1. Pot holes:
   - One (1) pot hole approximately 12 inches round.

2. Patches:
   - One (1) full width patch approximately 20 feet long in driving lane.

3. Transverse cracking:
   - Thirty-three (33) transverse cracks in various locations.

4. General:
   - This is a full depth asphalt pavement with thermal cracking spaced at 20 to 60 foot intervals.
   - All cracks have been routed 3/4" x 3/4" and sealed with Item D3405 (rubber modified sealer).

Region 8
Route I-84
"D" Number: D254001
Year Paved: 1992
Sealed: Various Locations
Inspected: East/West

Full width transverse cracking:
N= 0
L= 16
M= 0
H= 0

Longitudinal cracking:
N= 6%
L= 92%
M= 2%
H= 0%

Edge cracking:
N= 32%
L= 57%
M= 12%
H= 0%

Notes:
1. Ravelling:
   - Located on either side of bridge in east direction.

2. Pot holes:
   - One (1) pot hole at centerline in area of approach to bridge in east direction.

3. Core holes:
   - One (1) settled core hole patch.

4. Transverse joints:
   - Twenty (20) transverse cracks in various locations.

5. Night joints:
   - Two (2) cracked night joints.

Region 8
Route I-84
"D" Number: D254428
Year Paved: 1993
Sealed: Yes
Inspected: East/West

<u>Full width transverse cracking:</u>
N= 0
L= 2
M= 0
H= 0

<u>Longitudinal cracking:</u>
N= 3%
L= 92%
M= 5%
H= 0%

<u>Edge cracking:</u>
N= 34%
L= 37%
M= 29%
H= 0%

<u>Notes:</u>
1. Ravelling:
   - Multiple sections of ravelling at transverse joints, edge joints and centerline joints.

2. Pot holes:
   - Several pot holes in various locations at bridges.

3. Patches:
   - Six (6) patches in various locations.

4. Core holes:
   - Eight (8) settled core hole patches.

5. Transverse joints:
   - Eight (8) transverse cracks.

6. Night joints:
   - Two (2) night joints within test sections are cracked full width in the east direction.

7. Edge cracking:
   - Sections of edge cracking rated medium are open approximately 1 inch with pieces missing (approximately 10% of medium cracks).

8. Pumping:
   - Along edge of driving lane and shoulder between thruway markers 9.0 and 9.1.
   - Located within patched areas at bridge approaches.

Region 9
Route 17
"D" Number: D254070
Year Paved: 1992
Sealed: No
Inspected: East/West

<u>Heaves:</u>
P= 2

<u>Full width transverse cracking:</u>
N= 0
L= 33
M= 0
H= 0

<u>Longitudinal cracking:</u>
N= 0%
L= 95%
M= 5%
H= 0%

<u>Edge cracking:</u>
N= 47%
L= 23%
M= 30%
H= 0%

<u>Longitudinal cracking centerline of lane:</u>
DL= 10%
PL= 5%

<u>Notes:</u>

1. Transverse joints:
    - Seven (7) transverse cracks in various locations.

2. General:
    - Bridge approach in east direction has multiple edge cracking with pot holes.
    - Between bridges at Broome Co. line the pavement joints have been sawed/sealed.
    - Last 1.5 miles of paving in east bound direction, before start of 1993 Heavy Duty job, is paved with crumb rubber.

Region 9
Route 17
"D" Number: D254537
Year Paved: 1993
Sealed: No
Inspected: East/West

Heaves:
P= 3

Full width transverse cracking:
N= 0
L= 2
M= 0
H= 0

Longitudinal cracking:
N= 65%
L= 35%
M= 0%
H= 0%

Edge cracking:
N= 30%
L= 57%
M= 13%
H= 0%

Notes:
1. Patches (Ravelled winter of 1993-1994 and replaced summer 1994):
   - 60 feet long, full width of passing lane (east bound).
   - 60 feet long, full width of driving lane (east bound).
   - 15 feet long, full width of driving lane (east bound).
   - 250 feet long, full width of passing lane (east bound).
   - 1000 feet long, full width of passing lane (east bound).
   - 1200 feet long, full width of passing lane (east bound).
   - 250 feet long, full width of driving lane (west bound).
   - 100 feet long, full width of passing lane (west bound).

2. Night joints:
   - Four (4) cracked night joints
   - Many coarse areas were observable at night joints where the next days paving began.

3. Pumping:
   - 20 feet to 30 feet of pumping along edge joint heading east.
   - Two sections 2 feet to 3 feet along edge joint heading east.

4. Heaves:
   - Three (3) heaves in various locations.

5. General:
   - Longitudinal crack in center of driving lane approximately 20 foot long.
   - Entire east bound direction (seven miles) of top paved in 1993 and three (3) miles west bound paved in 1993. Remaining four (4) miles of top paved in 1994.

APPENDIX C

LOWER LIMIT ANALYSIS

HEAVY DUTY PAVEMENT CORE DATA ANALYSIS

%MADMTD 1	%MADMTD 2	%MADMTD 3	%MADMTD 4	%MADMTD AVE.	SD	91–97% PWL	91–97% QAF	92–97% PWL	92–97% QAF	Dff. PWL	Dff. QAF
92.982	94.338	93.022	94.817	93.790	0.9302	100.00	105.00	100.00	105.00	0.00	0.00
93.101	93.418	93.140	95.916	93.894	1.3555	100.00	105.00	96.86	102.39	3.14	2.61
93.129	93.884	94.361	95.552	94.232	1.0158	100.00	105.00	100.00	105.00	0.00	0.00
92.948	94.263	93.426	95.498	94.034	1.1171	100.00	105.00	100.00	105.00	0.00	0.00
94.310	95.225	93.991	96.339	94.966	1.0541	100.00	105.00	100.00	105.00	0.00	0.00
95.094	95.373	95.293	95.652	95.353	0.2314	100.00	105.00	100.00	105.00	0.00	0.00
94.007	94.527	95.725	94.407	94.666	0.7399	100.00	105.00	100.00	105.00	0.00	0.00
93.360	94.520	95.560	93.080	94.130	1.1391	100.00	105.00	100.00	105.00	0.00	0.00
95.687	97.005	95.487	94.768	95.737	0.9328	95.43	101.20	95.43	101.20	0.00	0.00
94.057	93.538	94.815	93.937	94.087	0.5335	100.00	105.00	100.00	105.00	0.00	0.00
93.453	93.054	94.850	95.569	94.232	1.1782	100.00	105.00	100.00	105.00	0.00	0.00
94.789	94.272	93.556	93.556	94.043	0.6010	100.00	105.00	100.00	105.00	0.00	0.00
94.666	95.382	93.471	94.108	94.407	0.8129	100.00	105.00	100.00	105.00	0.00	0.00
95.136	94.856	94.458	94.577	94.757	0.3028	100.00	105.00	100.00	105.00	0.00	0.00
93.745	92.390	92.948	93.347	93.108	0.5783	100.00	105.00	100.00	105.00	0.00	0.00
95.710	94.667	95.108	94.226	94.928	0.6336	100.00	105.00	100.00	105.00	0.00	0.00
94.500	94.819	96.174	94.301	94.948	0.8445	100.00	105.00	100.00	105.00	0.00	0.00
93.942	93.376	93.174	94.144	93.659	0.4581	100.00	105.00	100.00	105.00	0.00	0.00
94.134	95.112	93.320	94.868	94.358	0.8075	100.00	105.00	100.00	105.00	0.00	0.00
94.122	94.447	94.366	92.663	93.899	0.8357	100.00	105.00	100.00	105.00	0.00	0.00
93.786	90.820	93.095	93.826	92.882	1.4146	94.64	100.53	71.08	89.71	23.56	10.82
93.179	93.057	93.260	93.829	93.331	0.3419	100.00	105.00	100.00	105.00	0.00	0.00
93.117	91.741	93.198	92.713	92.692	0.6689	100.00	105.00	84.79	95.87	15.21	9.13
93.344	95.739	95.373	93.263	94.430	1.3094	100.00	105.00	100.00	105.00	0.00	0.00
93.445	92.590	94.422	93.933	93.597	0.7813	100.00	105.00	100.00	105.00	0.00	0.00

SAMPLING OF HEAVY DUTY PAVEMENT COMPACTION DATA

92.994	94.124	94.162	90.998	93.070	1.4835	96.80	102.33	74.33	91.18	22.47	11.16
95.045	93.646	94.629	94.705	94.506	0.6015	100.00	105.00	100.00	105.00	0.00	0.00
96.218	94.856	95.234	94.440	95.187	0.7598	100.00	105.00	100.00	105.00	0.00	0.00
93.072	92.463	92.082	92.311	92.482	0.4233	100.00	105.00	88.24	97.42	11.76	7.58
93.059	90.079	90.155	94.455	91.937	2.1777	64.64	86.82	49.34	79.95	15.30	6.87
93.323	92.364	92.786	93.400	92.968	0.4868	100.00	105.00	100.00	105.00	0.00	0.00
87.259	90.377	93.033	89.684	90.089	2.3749	37.51	74.64	23.47	68.34	14.03	6.30
94.434	93.512	92.322	94.741	93.752	1.0868	100.00	105.00	100.00	105.00	0.00	0.00
93.354	95.774	94.814	94.775	94.679	0.9971	100.00	105.00	100.00	105.00	0.00	0.00
92.736	93.044	93.121	93.505	93.101	0.3161	100.00	105.00	100.00	105.00	0.00	0.00
91.391	91.084	86.856	92.967	90.575	2.6125	44.87	77.95	32.11	72.22	12.76	5.73
93.917	92.019	92.445	94.382	93.191	1.1368	100.00	105.00	85.21	96.06	14.79	8.94
93.059	90.079	90.155	94.455	91.937	2.1777	64.64	86.82	49.34	79.95	15.30	6.87
92.427	93.449	92.465	92.200	92.635	0.5552	100.00	105.00	88.44	97.51	11.56	7.49
92.490	92.107	92.031	93.257	92.471	0.5609	100.00	105.00	78.30	92.96	21.70	12.04
92.067	92.715	92.296	92.334	92.353	0.2688	100.00	105.00	94.09	100.08	5.91	4.92
94.057	93.143	93.295	93.486	93.495	0.4000	100.00	105.00	100.00	105.00	0.00	0.00
95.180	94.118	93.586	93.359	94.061	0.8113	100.00	105.00	100.00	105.00	0.00	0.00
93.644	94.287	93.757	94.476	94.041	0.4034	100.00	105.00	100.00	105.00	0.00	0.00
92.456	91.664	92.795	92.116	92.258	0.4834	100.00	105.00	68.06	88.36	31.94	16.64
94.898	92.926	92.810	92.385	93.255	1.1197	100.00	105.00	87.65	97.16	12.35	7.84
95.043	96.359	93.222	95.933	95.139	1.3909	94.89	100.74	94.89	100.74	0.00	0.00
94.270	95.896	92.993	93.496	94.164	1.2689	100.00	105.00	100.00	105.00	0.00	0.00
92.293	90.318	87.064	93.029	90.676	2.6660	46.25	78.57	33.75	72.95	12.50	5.61
95.224	94.352	95.906	95.110	95.148	0.6366	100.00	105.00	100.00	105.00	0.00	0.00

%MADMTD >=91&<92	%MADMTD >=91&<92	%MADMTD >=91&<92	%MADMTD >=91&<92	TOTAL >=91&<92	AVG. SD	91–97% AVG PWL	91–97% AVG QAF	92–97% AVG PWL	92–97% AVG QAF	AVG. PWL CHANGE	AVG. QAF CHANGE
32	28	21	31	112	0.8406	96.90	103.30	91.41	100.01	5.49	3.29

TOTAL SUBLOTS	TOTAL LOTS	BEFORE = 105%	AFTER = 105%	DIFF. = 105%	PERCENT CHANGE	# PWL CHANGED	% PWL CHANGED
2080	520	439	355	84	19.13	149	28.65

% TOTAL >=91&<92		BEFORE >=100%	AFTER >=100%	DIFF. 100%	PERCENT CHANGE
5.38		465	375	90	19.35

APPENDIX D

EIC SURVEY - 1992

1992 HEAVY DUTY SPECIFICATION
SURVEY RESULTS

In December 92, the Bureau sent a survey to each of the Engineer's In-Charge of a project which utilized Heavy Duty asphalt concrete. There were a total of nine (9) projects which utilized the Heavy Duty mix. The following is a summary of the survey results:

1) *Was this your first project which utilized Heavy Duty asphalt concrete?*

   Seven (7) EICs used the HD specifications for the first time.
   Two (2) EICs had previously used the HD specifications.

   If "NO", please check the Heavy Duty specification items used on your previous project(s).

   Two (2) EICs had prior experience with the "14-Series" specifications.

2) *Would you prefer to use performance type specifications, such as the Heavy Duty, or the Standard specifications?*

   Seven (7) EICs would prefer to use performance type specifications.
   One (1) EIC would prefer to use the Standard specifications.
   One (1) EIC was not sure.

3) *Did you encounter any difficulties with the Contractor in enforcing the Heavy Duty specifications?*

   All nine (9) EICs did not encounter any difficulties in enforcing the specifications.

4) *In the Heavy Duty specifications, statistics were used to analyze the core and mix sample results for determining the Quantity Adjustment Factor. In your opinion, was the statistical portion of the specification easily understood by:*

   a) Yourself
   b) Your Staff
   c) Contractor

   a) Six (6) EICs understood the statistical portion of the specifications, and three (3) did not.
   b) Six (6) EICs indicated that their staff understood the statistical portion and three (3) did not.
   c) Six (6) EICs indicated that the contractor understood the statistical portion of the specifications. One (1) EIC indicated that a contractor did not understand and two (2) EICs did not find out.

If "NO" to Q4a, do you think it hampered your ability to enforce the specifications?

The three (3) EICs who did not understand the statistical portion of the specification claimed it did not hamper their ability to enforce the specifications.

5) *Did the Producer for your project have a Quality Control person at the plant to monitor the quality of mix?*

Eight (8) EICs indicated that producers had a quality control person at the plant.
One (1) EIC indicated that the producer did not have a quality control person at the plant.

6) *In your opinion, was the construction of the test strip beneficial?*

All nine (9) EICs indicated that the construction of a test strip was beneficial.

7) *Were you satisfied with the rolling pattern used by the contractor on your project?*

Seven (7) EICs were satisfied with the rolling pattern.
Two (2) EICs were not satisfied.

8) *Did the pattern vary from day to day to address changes in the mix, environment, or site?*

Five (5) EICs indicated that the rolling pattern was varied to address changes in the mix.
Four (4) EICs indicated that the rolling pattern was not varied.

9) *Did the contractor use a Nuclear Gauge to monitor the pavement density?*

All nine (9) EICs indicated that the contractor used a nuclear gauge to monitor the pavement density.

10) *In your opinion, was the person operating the gauge controlling the rolling pattern adequately?*

All nine (9) EICs indicated that the gauge operator was adequately controlling the rolling pattern.

11) *The Heavy Duty Specifications require the calculation of the tonnage placed in the areas where Quantity Adjustment Factors apply. Did you have problems in determining the tonnage?*

Eight (8) EICs indicated they did not have problems calculating the tonnage.
One (1) EIC had problems.

Was this calculation burdensome?

Eight (8) EICs indicated the calculation was not burdensome.
One (1) EIC indicated that the calculation was burdensome.

12) *Did the Contractor take extra core samples?*

Eight (8) EICs indicated the contractor took extra core samples.
One (1) EIC indicated the contractor did not take extra core samples.

If "YES", what were the cores taken for (i.e. updating Nuclear Gauge, verify State test results, etc)?

The duplicate cores were taken to update the contractor's nuclear gauges and to verify the State lab test results.

13) *Briefly explain how and when the core holes were back-filled, and by whom?*

Generally, the core holes were back filled by the contractor on the same day when the cores were taken.
One (1) EIC indicated that the core holes were filled as soon as the core was removed.
Two (2) EICs indicated that the core holes in the first lane were filled when the second lane was paved.
Four (4) EICs indicated the core holes were compacted by a hand held temper or a vibratory roller operating in the static mode.

Do you feel the method used was adequate?

Five (5) EICs were satisfied with the method used to fill the core holes.
Three (3) EICs were not satisfied.
One (1) EIC did not respond.

Comments:
a) One (1) EIC suggested a time limit (number of days) and compaction method to backfill the core holes be included in the HD specifications.
b) One (1) EIC suggested that a separate material be specified to fill the core holes.

14) *Are you satisfied with the quality of the pavement (i.e. texture, smoothness, rideability, etc) constructed using the Heavy Duty Items?*

Six (6) EICs were satisfied with the quality of the pavement.
Two (2) EICs were not satisfied.
One (1) EIC did not respond.

15) *The current Heavy Duty Specifications are under revision for the 1993 construction season. If you have any suggestions or comments regarding the specifications that were not addressed in this questionnaire, please comment:*

a) Type 7F should not be used for HD mixes.

b) Because of the large aggregate size, the minimum thickness of Type 3 Binder should be 2 inches, in place of the current 1 ½ inches.

c) Placement temperature higher than 260° F should be specified.

d) Specify the compaction of the material placed in the core holes.

e) Address the segregation issue, such as emptying the hopper after every few trucks.

f) Quantity Adjustment Factors should be applied to ramps regardless of length.

g) Test strips should be required for shoulders and minimum density with QAF's should apply.

h) Take cores at the joints to determine if adequate compaction was applied.

i) The pavement subjected to QAFs should be clearly defined.

We also requested the contractors to send comments on their experiences, suggestions, and the changes they would like to see during the revision of the current HD specifications. The following is a summary of the comments from those EICs who responded:

a) It was verbally agreed upon at the pre-paving meeting that the core locations could be moved to another location if the material was not representative of the entire pavement. The contractor suggested adding this to the specifications.

b) Ravelling was a concern in areas where segregation was prevalent. Some modification to the current paving method may help.

c) One EIC suggested that the Department look into the use of nuclear gauges instead of taking cores to determine the pavement density, the Bureau has done this.

d) One EIC suggested the Department look into applying different statistical limits to individual Regions. The EIC believes that since different Regions have materials with different characteristics, compaction results may vary.

APPENDIX E

EIC SURVEY - 1994

1994 HEAVY DUTY SPECIFICATION
SURVEY RESULTS

In October 94, the Bureau sent a survey to each of the Engineer's In-Charge of a project which utilized Heavy Duty asphalt concrete. There were a total of eleven (11) projects which utilized the Heavy Duty mix. The following is a summary of the survey results:

1) *Was this your first project which utilized Heavy Duty asphalt concrete?*

   Nine (9) EICs used the HD specifications for the first time.
   Two (2) EICs had previously used the HD specifications.

   If "NO", please check the Heavy Duty specifications items used on your previous project(s).

   One (1) EIC had prior experience with the "16-Series" specifications.
   One (1) EIC who also had prior experience with the HD specifications did not indicate which spec. he had experience with.

2) *Would you prefer to use performance type specifications, such as Heavy Duty, or Standard specifications?*

   Eight (8) EICs would prefer to use performance type specifications.
   One (1) EIC would prefer to use the Standard specifications.
   Two (2) EICs were indifferent toward the type of specifications they would like to use.

   Comments:
   a) Forces the Contractor to take more responsibility in achieving the quality product desired by the Department.
   b) HD specifications are limited to only compaction of the asphalt material, the specifications should also address rideability.

3) *Did you encounter any difficulties with the Contractor in enforcing the Heavy Duty specifications?*

   Two (2) EICs encountered difficulties enforcing the HD specifications.
   Nine (9) EICs did not encounter difficulties enforcing the HD specifications.

   Comments:
   a) Project Superintendent monitored paving crew to assure good results were being achieved.
   b) Contractor disputed coring locations when inconsistent gauge readings occurred.

4) *In the Heavy Duty specifications, statistics where used to analyze the core and mix sample results for determining the Quantity Adjustment Factor. In your opinion, was the statistical portion of the specifications easily understood by:*

a) Yourself
b) Your Staff
c) Contractor

a) Eight (8) EICs understood the statistical portion of the specifications, two (2) did not understand, and one (1) somewhat understood.
b) Six (6) EICs indicated that their staff understood the statistical portion of the specifications and five (5) did not.
c) Ten (10) EICs indicated that the contractor understood the statistical portion of the specifications. One (1) EIC indicated that the contractor did not understand.

If "NO" to Q4A, do you think it hampered your ability to enforce the specifications?

The two (2) EICs who did not understand the statistical portion of the specifications claimed that it did not hamper their ability to enforce the specifications and one (1) EIC indicated it somewhat hampered his ability.

5) *Did the Producer for your project have a Quality Control person at the plant to monitor the quality of the mix?*

All eleven (11) EICs indicated the producer had a quality control person at the plant.

If "YES", what testing was performed?

a) Visual inspection only, maintained direct contact with Contractor.
b) Performed extractions, gradations, Rice tests and stockpile monitoring.
c) Performed Rice tests.
d) Performed Rice tests and preliminary core testing.

6) *In your opinion, was the construction of the test strip beneficial?*

Nine (9) of the EICs indicated that the construction of the test strip was beneficial.
Two (2) EICs indicated it was not beneficial.

Comments:
a) Establishment of a rolling pattern which yielded the best compaction results.
b) Two (2) EICs indicated that the test strip should be longer to allow for a more representative pavement structure.
c) Provided a chance to observe rolling techniques and make adjustments to the rolling pattern.

7) *Were you satisfied with the rolling pattern used by the contractor on your project?*

Nine (9) EICs were satisfied with the rolling pattern.
Two (2) EICs were not satisfied.

8) *Did the rolling pattern vary from day to day to address the change in the mix, environment, or site?*

Five (5) EICs indicated the rolling pattern was varied to address changes in the mix.
Six (6) EICs indicated the rolling pattern was not varied.

<u>Comments:</u>
a) Temperature of mix and rate of heat loss dictated changes in rolling pattern.
b) Patterns varied from day to day or load to load to achieve the desired compaction.
c) Generally no, however variations were made to the rolling pattern occasionally to address changes in the mix, environment, or site.
d) An additional roller was added due to lower than desired pavement density.

9) *Did the contractor use a Nuclear Gauge to monitor the pavement density?*

All eleven (11) EICs indicated that the contractor used a Nuclear Gauge to monitor pavement density.

10) *In your opinion, was the person operating the gauge controlling the rolling pattern adequately?*

Eight (8) EICs indicated that the gauge operator was controlling the rolling pattern.
Two (2) EICs indicated the gauge operator was not adequately controlling the rolling pattern.
One (1) EIC was not sure.

<u>Comments:</u>
a) Any areas of low density were again rolled before the pavement cooled. Rolling was halted when density declined.
b) Different gauge operator frequently, were very inexperienced, density results suffered.
c) Different gauge operator frequently, density results varied depending on the operator.
d) Gauge operator did not control operation until he was encouraged to by the contractor.
e) Contractor used own method to control rolling, only used the person from Advanced Testing to take gauge readings at coring locations and to take cores.

11) *The Heavy Duty specifications require the calculation of the tonnage placed on the areas where Quantity Adjustment Factors apply. Did you have problems in determining the tonnage?*

All eleven (11) EICs indicated they did not have problems calculating the tonnage.

Was this calculation burdensome?

All eleven (11) EICs indicated the calculation was not burdensome.

<u>Comment:</u>

Need to keep track of each delivery ticket; then calculation is very easy. Used a TCI inspector for calculation.

12) *Did the contractor take extra core samples?*

Nine (9) EICs indicated the contractor took extra core samples.
Two (2) EICs indicated the contractor did not take extra core samples.

If "YES", what were the cores taken for (i.e. updating Nuclear Gauge, verify State test results, etc.)?

The duplicate cores were taken to update the contractor's nuclear gauges and to verify the State lab results.

13) *Briefly explain how and when the core holes were back-filled and by whom?*

Five (5) EICs indicated the core holes were backfilled daily with HD material using a vibratory roller operating in the static mode on the next pass.
Four (4) EICs indicated the core holes were backfilled daily with HD material using a hand tamper. One (1) EIC indicate the contractor used two lifts of hot mix material.
Two (2) EICs indicated the core holes were backfilled the next day with HD material using a hand tamper.
Two (2) EICs indicated the core holes were occasionally backfilled the next day with HD material using a hand tamper.

Do you feel the method used was adequate?

Seven (7) EICs were satisfied with the method used to fill the core holes.
Two (2) EICs were not satisfied.
Two (2) EICs indicated that the method used was satisfactory.

<u>Comments:</u>

a) Presently, no problems at core locations two months after paving completed.
b) Core holes must be filled with enough material initially to attain good results.
c) One (1) EIC indicated an epoxy mix or Quick Setting Tight Special Mix should be required.
d) One (1) EIC indicated more attention needs to be given to this issue. A guideline should be included in the HD Specification to address filling core holes.
e) See no reason to allow a double set of cores to be taken.

14) *Are you satisfied with the quality of the pavement (i.e. texture, smoothness, rideability, etc.) constructed using the Heavy Duty Items?*

One (1) EIC indicated the quality of the pavement was excellent.
Five (5) EICs were satisfied with the quality of the pavement.
Five (5) EICs were not satisfied.

<u>Comments:</u>

a) Five (5) EICs indicated they were dissatisfied with the quality of the pavement due to poor rideability. One (1) EIC indicated that he spent a lot of time working with the contractor to improve the rideability.
b) Two (2) EICs commented on the poor centerline joints. Joints will crack if over rolled or rolled when too hot.
d) Difficult to get good transverse joints due to the course material.
d) Two (2) EICs indicated segregation occurred within the mix resulting in "open" areas (porous surface) in the mat.

15) *The current Heavy Duty Specifications are under revision for the 1995 construction season. If you have any suggestions or comments regarding the specifications that were not addressed in this questionnaire, please comment.*

a) Specifications should include coring at longitudinal joints to test construction.
b) A ride quality (smoothness) requirement with a method of measurement (such as Profilograph) with an incentive/disincentive payment is a must.
c) Incentives/disincentives should also be passed onto the asphalt plant to get the plant more involved.
d) Segregation of HD base and binder material would be minimized by requiring it to be produced from a standard batch plant without the use of silos. It is virtually impossible to eliminate segregation through a drum plant.
e) Stricter enforcement and standard enforcement policies from Region to Region to standardize producing, hauling, and placement procedures.
f) More experienced Department plant inspectors with adequate assistance to enforce and monitor operations are needed.
g) The Heavy Duty Specifications require the same rolling pattern to be used on both mainline and shoulders. In some cases the subbase under the shoulders is constructed of different material than the mainline and cannot sustain the same compactive effort.
h) Full T & L course before HD items.
i) One EIC felt that the 5% bonus was not needed because the Department should be getting what is specified without an added bonus; however, another EIC indicated the 5% bonus was needed to get the attention of the contractor and provide an incentive to do the best possible job.